SRI APPLICATION IN RICE PRODUCTION
IN NORTHERN ECOLOGICAL AREAS OF VIETNAM

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For rice production in Vietnam in general and in there Northern delta in particular, there is an evident problem of overuse of chemical fertilizer (especially nitrogen) and of seed. High application of nitrogen and high transplanting density have become major reasons for rice crop vulnerability to pests, resulting in decreased yield, lower economic efficiency, and deteriorating environment. Overuse of chemicals (fertilizers, pesticides, etc.) that pollute the environment affect the environment's health. In order to solve this situation, since 2003 the National IPM Programme has been introducing the *System of Rice Intensification (SRI)* to IPM farmers for experimentation. Based on SRI principles, IPM trainers and IPM farmer groups together have studied and developed the training procedure for farmers to apply SRI.

In 2005, SRI was applied on a larger scale, ranging from 2-5 ha for each site in 14 provinces across the country. In 2006, SRI was applied in 17 provinces with the participation of 3,450 farmers (*see the attached annex*). The results showed that due to SRI application, the seed volume can be reduced by 70-90% in comparison to conventional farmer practice. The volume of nitrogen applied has been reduced by 20-25%. Average yield has been increased by 9-15%. The healthier crop leads to good resistance against pests and to a significant reduction of pesticide use in the field.

The profit in SRI fields has been increased on average by more than 2 million VND/ha (>$125), while cost of production for paddy rice has been reduced by from 342 VND to 520 VND per Kg (2-3 US cents). Moreover, farmers can save around one-third of usual volume of water. The results of SRI application showed that this technical system can play an important role in the sustainable development of irrigated rice cultivation. SRI should be disseminated further and widely, allowing many more farmers to benefit from this new technology.

I. Technical issues for using SRI:

a. Healthy seed

b. Seedbed preparation:
- Low density (only 0.5kg/10 m^2) in garden-like soil or in trays.
- Seedling age: 2 - 2.5 leaves, carefully uproot the seedling to avoid damage to roots.

c. Land preparation: double plough, to have well turned-up soil, with deep, soft and level cultivation layer.

d. Transplanting:
- Appropriate density is one seedling/hill.
- Transplanting with square pattern, 25x25 cm or wider if soil is more fertile.
- Shallow transplanting (tenderly put seedlings into the soil, just 1-2 cm deep).

e. Fertilizer application: in accordance with recommended nutrition management practices.

f. Pest and insect management: to be done according to recommended IPM principles.

g. Water regulation: irrigate so as to keep the field dry (unsatjurated) during vegetative growth, keeping water with 3-4cm in depth during productive growth, and fully draining the field 15-20 days before harvesting.

II. Spread of SRI evaluations by province, 2003-2006

Since SRI evaluations were started in 2003, the number of trials and demonstrations has been increased year by year, as shown in Table 1. The total area of SRI applications amounted to 70 ha in 2006, with further expansions being made in the current year 2007.

Table 1: Participating provinces

2003	2004	2005	2006
3 provinces	5 provinces	12 provinces	17 provinces
Hanoi Hoa Binh Quang Nam	Hanoi Hoa Binh Quang Nam Nam Đinh Thai Binh	Hanoi Hoa Binh Nam Đinh Ninh Binh Thai Binh Hai Duong Hung Yen Ha Nam Ha Tay Nghe An Quang Binh Quang Nam	Hanoi Hoa Binh Nam Đinh Ninh Binh Thai Binh Hai Duong Hung Yen Ha Nam Ha Tay Nghe An Quang Binh Quang Nam Yen Bai Hai Phong Can Tho Hau Giang Soc Trang

III. Experience with variations in planting density with SRI

The results in Table 2 show that over two years time in the 11 Northern provinces, there have been 13 varieties included in the evaluation, most of them hybrid rice varieties or Chinese pure rice strains. They were planted in medium-level and upper-medium-level soil conditions with proactive water regulation.

Table 2: SRI transplanting density for different varieties in 2005-2006

No.	Province	Variety	Transplanting density			
			SRI		Farmer	
			Hill/m^2	Seedling/m^2	Hill/m^2	Seedling/m^2
1	Yen Bai	Chiem huong, Nhi uu 838, HT 1	25	25	45-48	180-192
2	Hoa Binh	K.D18, Phuc tien	25	25	45	180
3	Ha Tây	KD18	20-25	20-25	40-45	160-180
4	Ha Noi	K.Dan 18	16	16	40	160
5	Hung Yen	KD18, IRi 352, Q5	42	42	50	200
6	Hai Duong	D.uu 527, D18,Q5	36	36	45	180
7	Hai Phong	K.Dan 18	32	32	40	160
8	Thai Binh	Hybrid, inbred (Chinese)	32	32	40	160
9	Ha Nam	Nhi uu 838, K.D18	25-32	25-32	40-45	160-180
10	Nam Đinh	Hybrid, inbred (Chinese)	25-32	25-32	28-36	84-144
11	Ninh Binh	Hybrid, Ai 32	25-36	25-36	30-45	120-180

In the experiments, all the participating provinces applied the densities of 11, 16, 20 and 25 hills/m^2. With the same conditions of 2.5-leaf seedling transplanting, one-seedling transplanting, square-patterned transplanting and regular water drainage in productive stage, the most suitable density which brings about the highest yield and most cost-effectiveness varies among the different varieties and soil conditions. The selected density from the experiment ranges from 16 hills/m^2 (Ha Noi) to 42 hills/m^2 (Hung Yen), mostly being around 25-32 hills/m^2.

The results in Table 2 are also similar to previous research by scientists. That is, with fertile soil, low transplanting density gives better results, while poor soil requires higher density. The varieties which have a high tillering capacity get along well with low transplanting density, whereas those with lower tillering capacity require higher transplanting density.

The summary in Table 2 also indicates that it is undesirable to apply a common density to all varieties, all soil conditions, and each cultivating season.

IV. Experience with varietal differences, spacing, and seed-saving

The results in Table 3 show that with suitable transplanting density, the seed use can be reduced significantly in comparison with that of farmer practice under the same conditions. The reduction varies from 79% (Hung Yen) to 90% (Ha Noi) as the smallest and biggest differences, with most reductions between 80% and 84%. The reduction was possible because of: reduced transplanting density and less number of seedlings per hill (one-seeding transplanting in experiments versus 3-4 seedlings with farmer practice). Such reduction is really meaningful to the areas where people use hybrid variety imported from China.

Table 3: Varieties used in participating provinces in 2005 - 2006

No.	Province	Experimented varieties	Selected density		Difference from farmer practice (%)
			Hill/m^2	Seedling/m^2	
1	Yen Bai	Chiem Huong, Nhi Uu 838, HT 1	25	25	86-87
2	Hoa Binh	K.Dan18, Phuc Tien	25	25	86
3	Ha Tay	K.Dan 18	20-25	20-25	87.5-86
4	Hanoi	K.Dan 18	16	16	90
5	Hung Yen	KD18, IRi 352, Q5	42	42	79
6	Hai Dương	D.Uu 527, D18, Q5	36	36	80
7	Hai Phong	K.Dan 18	32	32	80
8	Thai Binh	Chinese pure and hybrids	32	32	80
9	Ha Nam	Nhi Uu 838, K.D 18	25-32	25-32	84.3-82.2
10	Nam Dinh	Chinese pure and hybrids	25-32	25-32	70.3-77.8
11	Ninh Binh	Hybrids, Ai 32	25-36	25-36	79.1-80

V. SRI application and reduction in pesticide use

The results in Table 4 show that applying SRI methods helped reduce the pesticide sprays by from 0.5 times/season to 2 times/season (1.5 times/season on average) in comparison with farmer practice under the same conditions. Such results were achieved due to the fact the some pests such as sheath blight, leaf blight, small leaf folder, and brown planthopper (BPH) in experiment plots always had smaller populations than in farmers' practice plots.

Table 4: Number of sprayings per season in some provinces, 2005-2006

No.	Province	Number of sprays/season		
		Experiment	Farmer	Difference (sprays/season)
1	Yen Bai	1	3	2
2	Hanoi	1	2	1
3	Ha Tay	0.5	1.5	1
4	Hai Dương	1	2.5	1.5
5	Hung Yen	2	5	3
6	Thai Binh	1	2	1
7	Hai Phong	2	4	2
8	Ha Nam	2	4	2
9	Ninh Binh	1	1.5	0.5
	Average	**1.25**	**2.75**	**1.5**

VI. SRI application and reduced levels of pest infestation

A. Sheath blight

The results in Table 5 show that tThanks to the integrated treatment, SRI rice plants became stronger and had less shealth blight infection in experiment plots than that in farmers' practice plots. On average, shealth blight in treatment plots was reduced by 63% (spring season) and 74% (summer season) in comparison with the levels with farmer practice.

Table 5: Level of sheath blight infestation in some provinces in 2005-2006 (in percent)

No.	Province	Spring season			Summer season		
		Experi-ment	Farmer	Difference (%)	Experi-ment	Farmer	Difference (%)
1	Yen Bai	-	-	-	8.3	45.5	81.8
2	Ha Tay	2.6	15.5	83.2	11.2	25.7	56.4
3	Hai Phong	-	-	-	1.2	18.5	93.6
4	Thai Binh	5.2	12.5	58.4	2.9	18.6	84.4
5	Hai Duong	8.5	18.8	54.8	7.0	14.6	52.0
6	Hung Yen	9.8	27.5	64.4	3.2	19.5	83.6

7	Ha Nam	9.6	25.6	62.5	3.8	14.5	73.8
8	Nam Dinh	4.9	6.2	21.0	2.1	10.3	79.6
9	Ninh Binh	2.6	9.6	73.0	4.7	10.8	56.5
	Average	**6.7**	**18.1**	**63.0**	**5.2**	**19.8**	**73.7**

Shealth blight is one of the most common diseases apprearing in the rice field. However, using a specific fungicide with proper timing enables farmers to limit the disease infestation. The results showed that normally the farmers sprayed fungicide against shealth blight one or two times per season. In experiment plots, it was hardly necessary to use fungicide because of the slight infection.

B. Leaf blight

The results in Table 6 show that leaf blight in experiment plots was seen to be significantly less than in farmer-practice plots. The reduction percentage ranged from 35.5% (Thai Binh) up to 99.4% (Ha Tay), with 76.5% less on average.

Table 6: Leaf blight in some provinces in summer season in 2005-2006 (in percent)

No.	Province	Experiment	Farmer	Difference (%)
1	Yen Bai	0.5	32.5	98.4
2	Ha Tay	0.3	52.7	99.4
3	Thai Binh	33.1	51.3	35.5
4	Ha Nam	5.7	20.8	72.6
5	Nam Dinh	7.0	21.7	67.7
6	Ninh Binh	4.7	39.0	87.9
	Average	**8.55**	**36.3**	**76.5**

C. Small leaf folder

The results in Table 7 show that the small leaf folder population in experiment plots remained lower than in farmer-practice plots by 41.1% (winter spring) and 49.5% (summer autumn). Since 2000, small leaf folder had frequently appeared and caused damage during rice seasons, especially in highly intensive farming localities in Northern delta.

In summer season 2006, in Hung Dao commune, Tien Lu district (Hung Yen), it was common practice for farmers to apply 2-3 sprays against small leaf folder, while there was only one spray in a demonstration field of 2 ha. Similar results were also obseved in Tan Phuc commune, An Thi district (Hung Yen) and other sites in Nam Dinh, Ninh Binh and Thai Binh.

Table 7: Small leaf folder in some provinces in 2005-2006 (insects/m^2)

No.	Province	Spring season			Summer season		
		Experiment	**Farmer**	**Difference (%)**	**Experiment**	**Farmer**	**Difference (%)**
1	Hai Duong	13.2	26.2	49.6	9.6	23.0	58.3
2	Hung Yen	57.0	108.0	47.2	140.0	252.0	44.4
3	Thai Binh	53.0	74.0	28.3	39.5	60.0	35.0
4	Ha Nam	90.0	135.0	42.9	60.0	120.6	50.2
5	Nam Dinh	68.2	123.0	44.2	62.5	122.1	48.8
6	Ninh Binh	99.0	180.0	45.0	59.5	156.8	62.0
	Average	**63.4**	**107.7**	**41.1**	**61.8**	**122.3**	**49.5**

D. Brown plant hopper, and back-white hopper

The results in Table 8 show that the average hopper density in experiments was reduced with SRI management practices by 62.4% (winter spring) and by 83% in comparison with the levels in farmer-practice plots.

In summer season 2006, in Hung Dao commune, Tien Lu district (Hung Yen), in farmer plots with 50 hills/m^2 (Khang Dan 18 variety), there were between 8,000 and 10,000 insects/m^2, and farmers had to spray 2-3 times. In some plots where spraying was done with improper timing or without spraying, it was even impossible to harvest. On the other hand, it was not necessary to spray in demonstration fields.

Table 8: Brown plant hopper, back-white in some provinces in 2005-2006 (insects/m^2)

No.	Province	Spring season			Summer season		
		Experi-ment	Farmer	Difference (%)	Experi-ment	Farmer	Difference (%)
1	Ha Tay	1020	3200	68.2	1900	4230	54.6
2	Hai Duong	387	1413	78.8	471	3115	84.9
3	Hung Yen	525	1352	61.2	300	8000	96.2
4	Hai Phong	-	-	-	428	1960	78.2
5	Thai Binh	290	940	69.2	400	1238	67.7
6	Ha Nam	508	1060	45.3	81	3090	99.7
7	Nam Dinh	490	1050	53.3	710	2125	66.6
8	Ninh Binh	580	1060	45.3	71	1950	96.3
	Average	**542**	**1440**	**62.4**	**545**	**3214**	**83.0**

VII. Application of the System of Rice Intensification and factors affecting components of yield as well as rice yield

A. Application of SRI and number of panicles/hill and number of grains/panicle and grains/m^2

The results in Table 9 show that thanks to the application of the integrated system of rice intensification, the number of panicles per hill was greater than that in farmers' plots.

Table 9: Number of panicles/hill in some provinces in 2006

No.	Province	Spring season			Summer season		
		SRI	Farmer	Difference (%)	SRI	Farmer	Difference (%)
1	Ha Tay	6.7	5.1	31.4	7.5	5.0	50.0
2	Ha Nam	-	-	-	7.8	6.0	30.0
3	Nam Dinh	10.1	8.1	23.5	8.9	6.8	30.9
4	Ninh Binh	7.3	6.6	10.6	8.6	7.7	11.7
5	Hung Yen	6.1	5.1	19.6	5.2	4.5	15.6
6	Hai Duong	7.0	5.5	27.3	6.7	5.2	28.9
7	Hai Phong	-	-	-	7.8	6.6	18.2
8	Thai Binh	7.6	5.6	35.7	7.5	6.3	19.0
9	Yen Bai	-	-	-	8.7	6.0	31.8
	Average	**7.5**	**6.0**	**25.0**	**7.6**	**6.0**	**26.7**

The average number of panicles per hill in experiments increased the most, by 50% in Ha Tay (summer season) and the least by 10.6% in Ninh Binh (spring season). Overall, number was raised by 25% (spring season) and 26.7% (summer season) for all the provinces compared to that with farmers' practice.

Table 10: Number of productive grains/hill in some provinces in 2006

No.	Province	Spring season			Summer season		
		SRI	Farmer	Difference (%)	SRI	Farmer	Difference (%)
1	Yen Bai	-	-	-	136	101	34,6
2	Ha Tay	169	119	42,0	158	112	41,0
3	Ha Nam	-	-	-	126	109	15,6
4	Nam Dinh	124	116	6,9	136	131	3,8
5	Ninh Binh	162	146	11,0	130	107	21,5
6	Hung Yen	124	102	21,6	125	109	14,7
7	Hai Duong	132	115	14,8	144	126	14,3
8	Hai Phong	-	-	-	120	105	14,3
9	Thai Binh	135	108	25,0	129	101	27,7
	Average	**141**	**117**	**20,5**	**134**	**111**	**20,7**

The results in Table 10 show that with the application of integrated system of intensification, the number of productive panicles per hill in experiments was higher than that in farmers' plots. The highest achievement was in Ha Tay, with a raise of 42% and 41% in spring and summer seasons, respectively, in comparison with farmer practice. On average, the SRI experimental plots obtained greater number of panicles per hill by 20.5% and 20.7% in spring and summer season, respectively, than farmer plots.

Table 11: Number of productive grains/m^2 in some provinces in 2006

No.	Province	Spring season			Summer season		
		SRI	Farmer	Difference (%)	SRI	Farmer	Difference (%)
1	Yen Bai	-	-	-	29,580	27,270	8.5
2	Ha Tay	29,152	24,276	20.1	29,625	22,400	32.2
3	Ha Nam	-	-	-	31,450	27,468	14.5
4	Nam Dinh	31,310	31,007	1.0	30,260	28,505	6.2
5	Ninh Binh	29,565	28,908	2.3	27,950	24,717	13.1
6	Hung Yen	31,768	30,600	3.8	27,300	24,525	11.3
7	Hai Duong	33,264	28,462	17.0	32,310	29,484	9.6
8	Hai Phong	-	-	-	29,952	27,720	8.1
9	Thai Binh	32,832	25,402	29.2	30,960	26,764	11.7
	Average	**31,148**	**28,109**	**10.8**	**29,931**	**26,539**	**12.8**

The results in Table 11 showed that although the number of hills/m^2 in SRI experimental plots was lower, the number of productive panicles per square metre remained higher than that in farmer plots, because the former had a higher number of panicles per hill and also a higher number of productive grains per panicle. These were the factors that determined a higher yield in the experimental than in the farmer plots.

B. Application of SRI and impact on rice yield

The results in Table 12 show that in spring season, the average rice yield in SRI experiments of Nam Dinh was similar to that in normal farmers' fields, while in other provinces, the SRI yield was higher by 6.1 to 19.3%. In summer season, the average rice yield in experiments of Nam Dinh and Yen Bai was higher than that in normal farmers' fields, but only by 4.5%, while in other provinces the SRI yield was higher by 8.3 to 30.2%.

Table 12: Rice yield in some provinces in 2006 (tons/ha)

No.	Province	Spring season			Summer season		
		SRI	Farmer	Difference (%)	SRI	Farmer	Difference (%)
1	Yen Bai	-	-		6.8	6.5	4.6
2	Ha Tay	5.9	5.3	11.3	5.8	5.1	13.7
3	Ha Nam	-	-	-	6.5	6.0	8.3
4	Nam Dinh	7.5	7.3	2.7	7.0	6.7	4.5
5	Ninh Binh	7.0	6.6	6.1	6.6	5.1	29.4
6	Hung Yen	6.4	6.0	6.7	6.0	5.0	20.0
7	Hai Duong	6.8	5.7	19.3	6.8	5.6	21.4
8	Hai Phong	-	-	-	6.3	5.2	21.1
9	Thai Binh	7.0	6.1	14.8	6.9	6.3	30.2
	Average	**6.8**	**6.2**	**9.7**	**6.5**	**5.7**	**14.0**

VIII. Economic assessments of SRI effects

A. Application of system of rice intensification and economic efficiency

Because of SRI application, the input cost was reduced, with reductions of seed, nitrogen fertilizer, pesticides, and even water saving of 50% in some experiments, while the rice yield remained similar or even higher than that of conventional practice. As a result, the profit in experiments in both spring and summer seasons was higher than that in farmer fields by approximately 2,240,000 VND/ha.

Table 13: Economic efficiency of SRI application

No.	Province	Profit difference between SRI and farmer fields (1000 VND)		
		Spring season	Summer season	Average
1	Ha Tay	3,598	3,185	3,391
2	Ha Nam	-	2,587	2,587
3	Nam Dinh	782	1,736	1,259
4	Ninh Binh	2,301	2,527	2,414
5	Hung Yen	1,845	2,411	2,128
6	Hai Duong	1,804	2,339	2,071
7	Hai Phong	-	2,611	2,611
8	Thai Binh	1,920	2,108	2,014
	Average	**2,042**	**2,438**	**2,240**

B. SRI application and cost of paddy production

The results in Table 14 show that the price for one kilogram of paddy in experimental plots with SRI methods was reduced notably in comparison with paddy price for farmer field. In the spring season, the paddy cost price was reduced by between 207 and 597 VND/kg, with 342 VND/kg as the average. In summer season, the paddy cost price reduction ranged from 212 to 883 VND/kg, with around 520 VND/kg as the average. Such cost savings made use of SRI methods much more profitable.

Table 14: Per kilogram paddy cost of production in some provinces (VND)

No.	Province	Spring season			Summer season		
		SRI	Farmer	Difference (%)	SRI	Farmer	Difference (%)
1	Yen Bai	-	-	-	772	1,016	244
2	Ha Tay	1,228	1,623	395	1,264	1,893	629
3	Ha Nam	-	-	-	1,976	2,390	414
4	Nam Dinh	1,270	1,447	177	1,373	1,585	212
5	Ninh Binh	1,084	1,360	276	1,506	2,112	606
6	Hung Yen	1,178	1,578	400	1,466	2,349	883
7	Hai Duong	1,367	1,575	207	1,462	1,774	312
7	Hai Phong	-	-	-	1,595	2,276	681
9	Thai Binh	1,307	1,904	597	1,402	2,103	701
	Average	**1,239**	**1,581**	**342**	**1,424**	**1,944**	**520**

IX. SRI application and water saving

From 5 to 7 days after the first top application of fertilizer, farmers practicing SRI withdrew all the water in the experiment plots for at least 5-7 days (sometimes even longer) until there were cracks appearing in the field surface; or after water withdrawal, they allowed water to overflow into the field when raining, then kept the field wet but not flooded until the panicle initiation. From the panicle initiation stage to ripening stage, they kept water at 4-5 cm deep, and then withdrew all the water 15-20 days before harvesting.

In this way, farmers saved at least one time of watering (about 30% of water volume) in comparison with normal field practice. Thanks to this alternate flooding and drying pattern of water management, the SRI root systems developed deeper and wider, and the stems became stronger and more resistant against heavy wind by the end of the season (summer seasons 2005 and 2006).

X. Conclusions and recommendation

Based on the achievements from 2003-2006, we can draw the following conclusions:

1. SRI application can help save production inputs: seed, fertilizer, pesticide, and water, and can reduce associated costs of production. For example:

- The transplanting density (hills/m^2) in experimental SRI plots was reduced from 16% (Hung Yen) to 60% (Hanoi) compared to that in normal farmer fields.

- The transplanting density (panicles/m^2) in experimental SRI plots was reduced from 79% (Hung Yen) to 90% (Hanoi) compared to that in normal farmer fields. As a result, the seed requirement was reduced accordingly.

- The volume of nitrogen fertilizer used in SRI treatment plots was reduced by 22.8% (spring season) and 24.6% (summer season) in comparison with that of farmer practice.

- The number of pesticide sprays in experimental plots was reduced by approximately 1.5 times, and even by 3-4 times in seasons with pest outbreaks.

- The number of panicles/hill increased by 25% and 26.7% in spring and summer seasons, respectively; the number of productive grains/m^2 increased by 10.8% and 12.8% in spring and summer seasons, respectively; the rice yield increased by 9.7% and 14% in spring and summer seasons, respectively, in comparison with farmer practice.

- Net profit in SRI experimental plots increased by 2,042,000 VND and 2,240,000 VND per ha in spring and summer seasons, respectively.

- Per kilogram paddy cost of production was reduced by 342 VND and 520 VND in spring and summer seasons, respectively.

2. SRI application is a technical solution that can be adapted within the instructions for **3 Reductions, 3 Gains** in rice production in the north.

3. The System of Rice Intensification is recommended for rice production in some northern ecosystems. Systematic evaluations in southern ecosystems remain to be carried out.

Recommendation:

That the Scientific and Technology Council under Ministry of Agriculture and Rural Development recognise SRI as a technology advance.

[Note: After receiving and considering this report from the National IPM Program in early April 2007, the Council for Science and Technology of the Ministry of Agricultural and Rural Development accepted this recommendation and will issue a letter that will enable Provinces to get financial support for application of SRI, and research institutes to get funding for further SRI studies.]